# Passenger car data – a new source of real-time weather information for nowcasting, forecasting, and road safety

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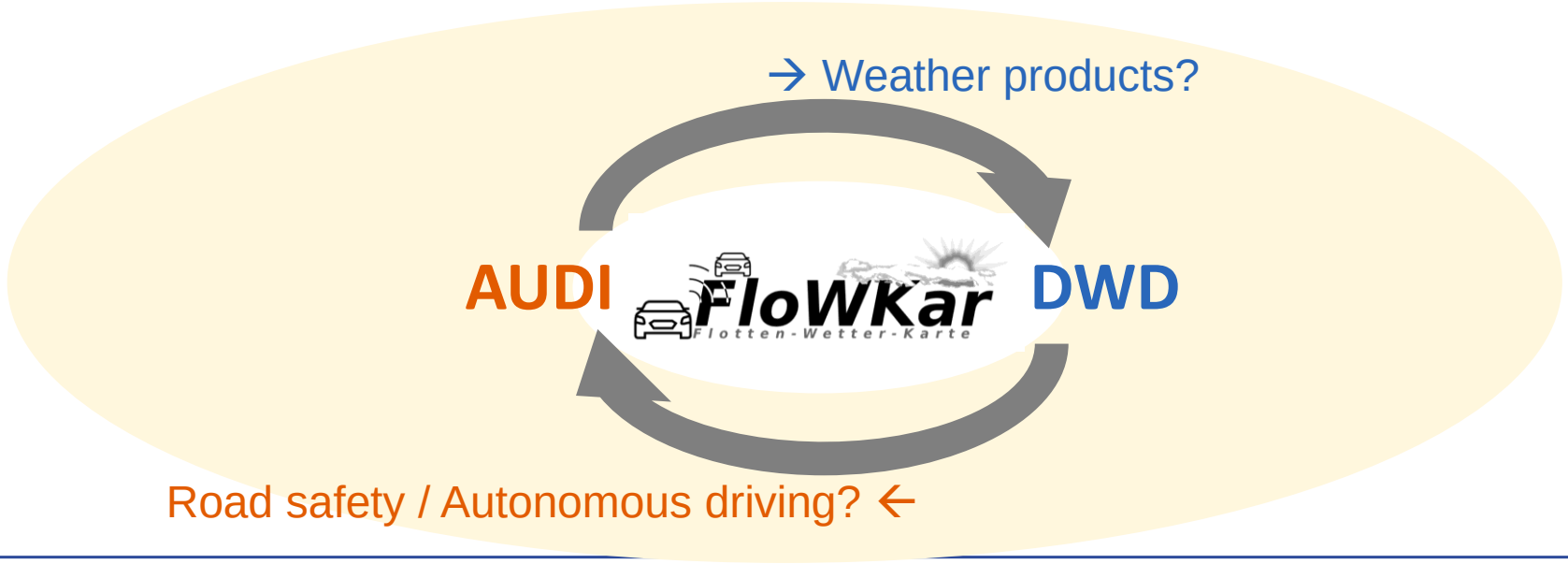
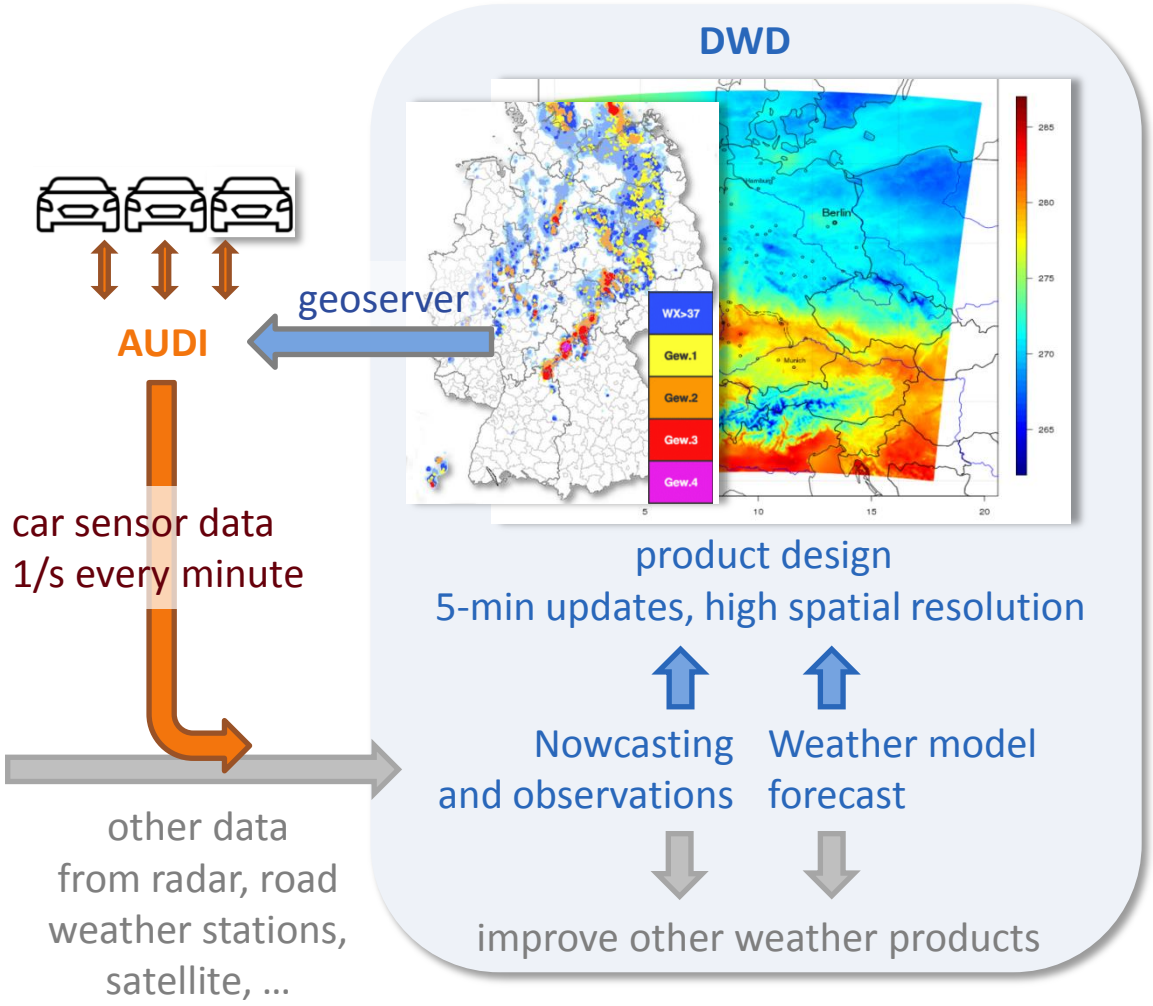


# Goal: real-time weather for roads



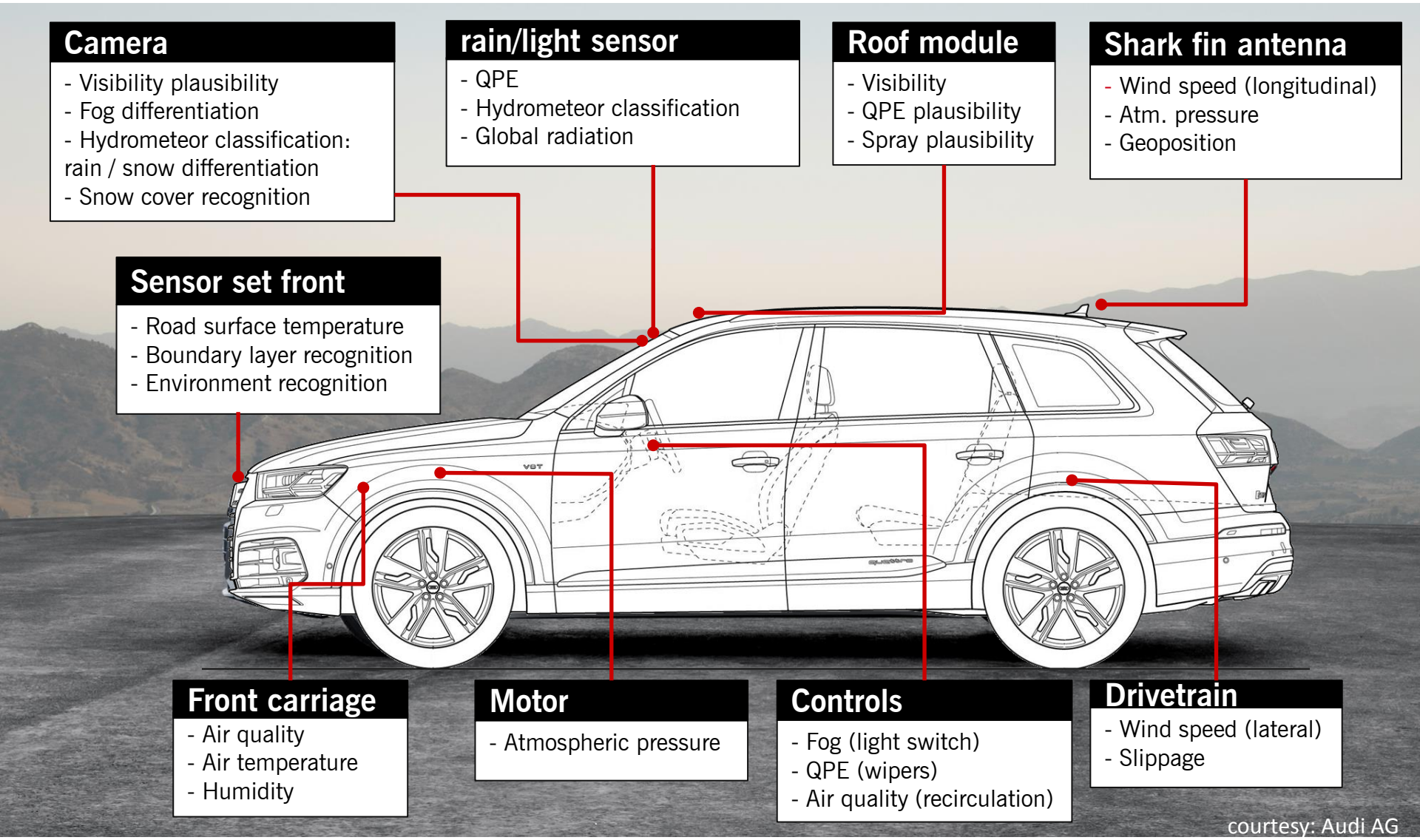



→ Optimal combination of nowcasting und short-range weather forecast

→ **Weather product** for **road users** including, e.g., slipperiness (air and road temperature, humidity, road condition, heavy rain, freezing rain), reduced visibility (fog, heavy rain, snow), stability of vehicle (strong gusts), comfort (heat, global radiation, hail)

# Car sensor set (experimental)

Deutscher Wetterdienst
Wetter und Klima aus einer Hand




courtesy: Audi AG

# Potential of car sensor data: Hymec

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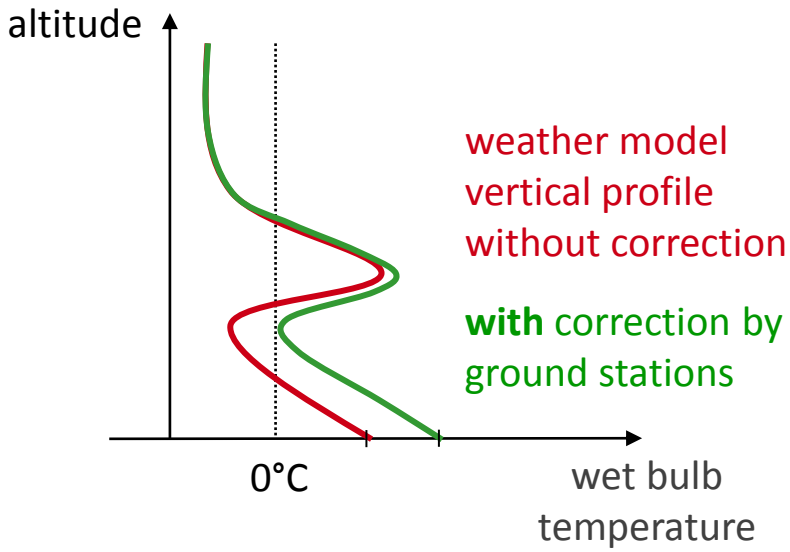
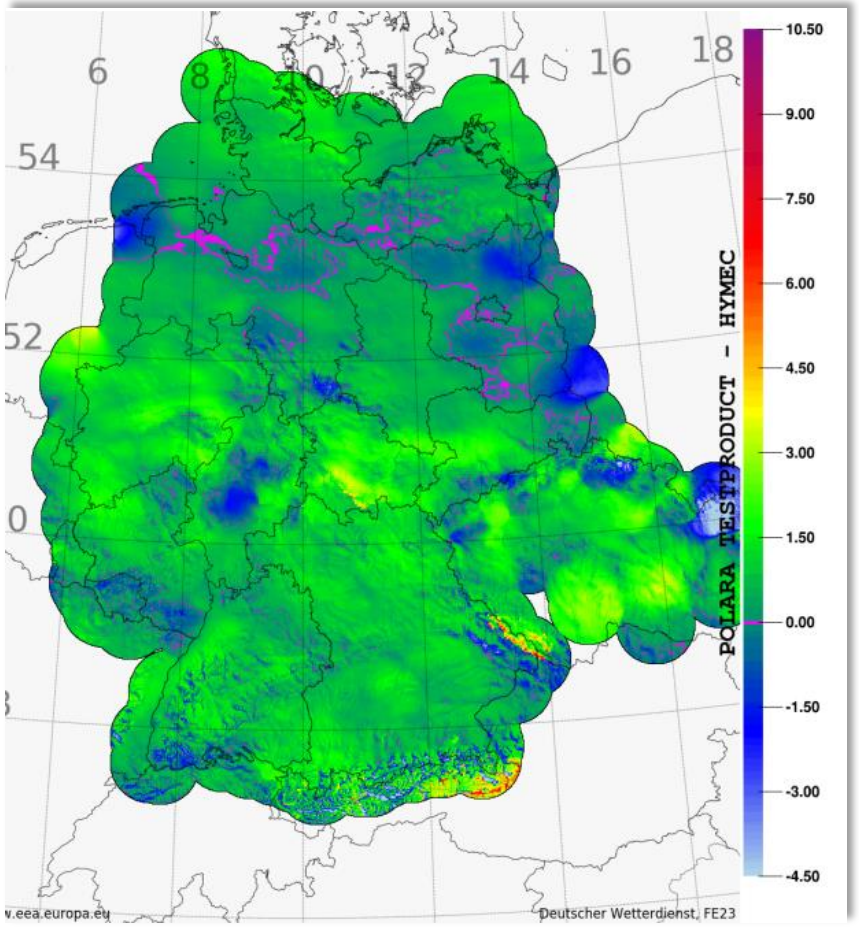
**temperature + humidity → rain, snow, hail?**




- Better temperature and humidity in the boundary layer

→ better **hydrometeor classification**

→ **slipperiness, visibility, comfort (hail)**




difference in wet bulb temperature at 2m above ground: obs – model

courtesy: Jörg Steinert, DWD

# Potential of car sensor data: precipitation

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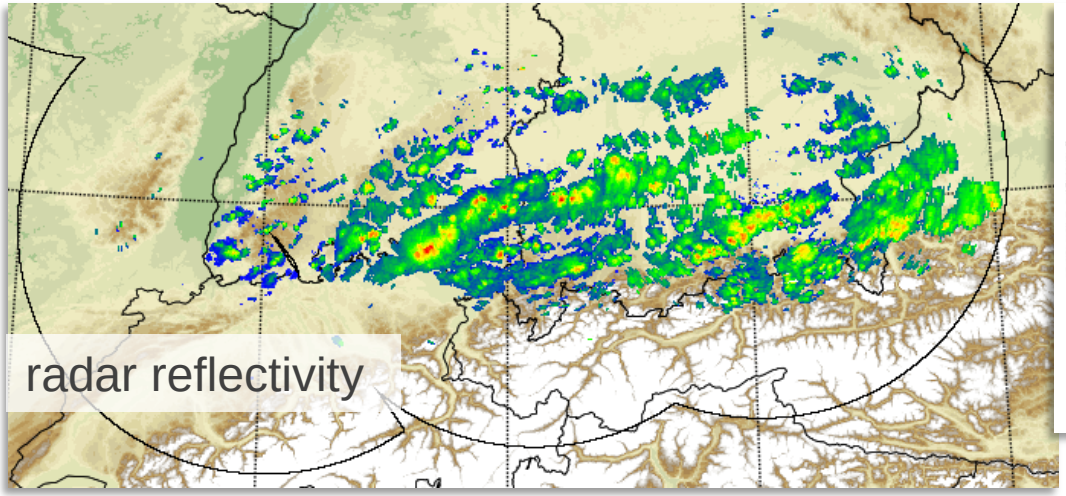
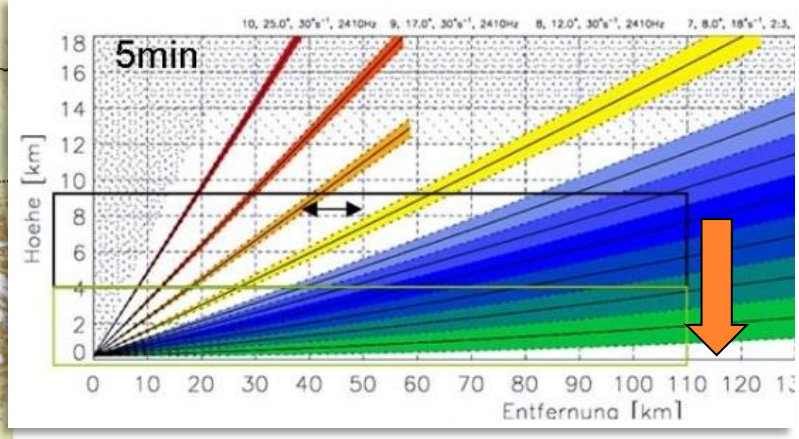
**precipitation? → "no" is data, too!**




radar sweep height with distance




possible evaporation or wind drift from sweep height to ground

- **Is rain detected by radar reaching the ground?** (evaporation, wind drift) no → **reduce false alarm**

# Potential of car sensor data: precipitation



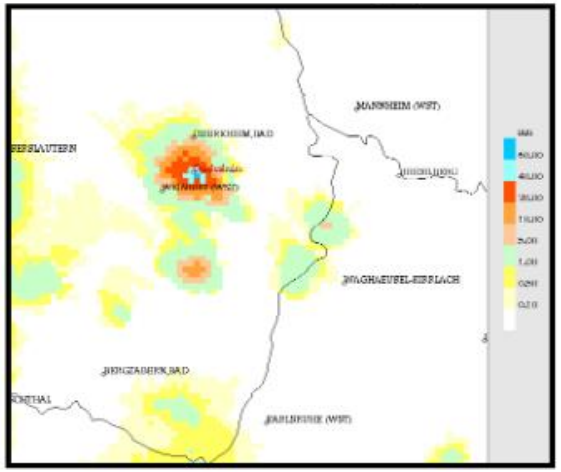
## amount of precipitation

rain gauges

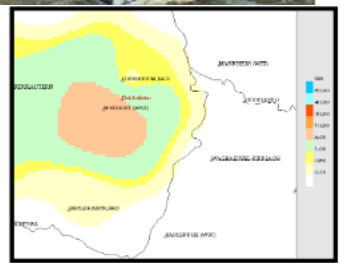
+

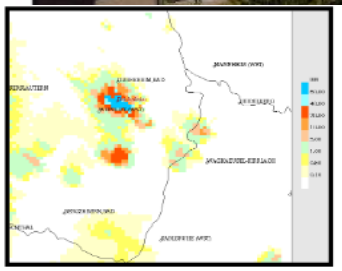
weather radar

=




RADOLAN

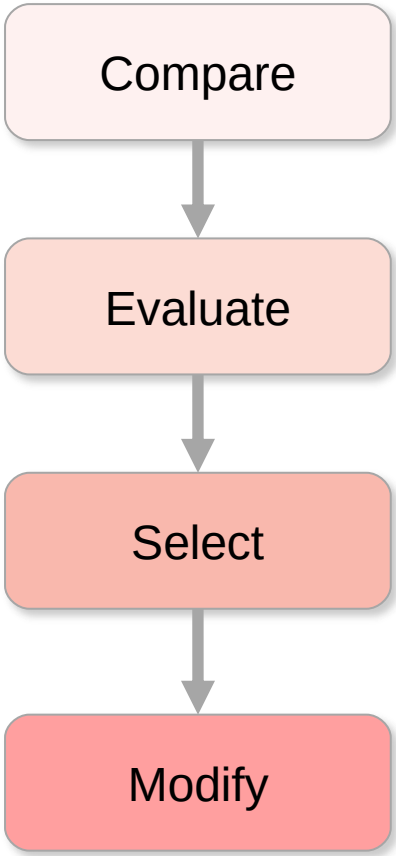




- car rain sensor provides ml/(m²*s) → calibration of radar at ground …?

# How to deal with new data (for nowcasting)






How do **new** data compare to **operationally** used weather observations and products?

- **Station** data: (road) weather stations
- → Interpolated temperature observations
- **Radar** data **sweeps** and **composites**
- **combined products**: fuzzy logic (NowCastMIX), radar + station data (RADOLAN)

To what extent are they **comparable**?

- **where, how, when**? (representativeness)
- ground vs. radar sweep height
- point vs. area (spatial resolution)
- time resolution, time point

Which **car sensor variables** are **valuable** for (road) weather prediction?

- **near ground**
- temperature and humidity
- **→ rain, snow, hail, slipperiness**
- precipitation
- **→ rain yes/no, hydroplaning, …**

**New** / modified **products** based on car sensor data

- relate to existing data and products
- optimal fusion / weighting
- **→ focus on clients, application in road traffic**
- **→ how can other weather products**

# Comparison precipitation DWD <-> Audi

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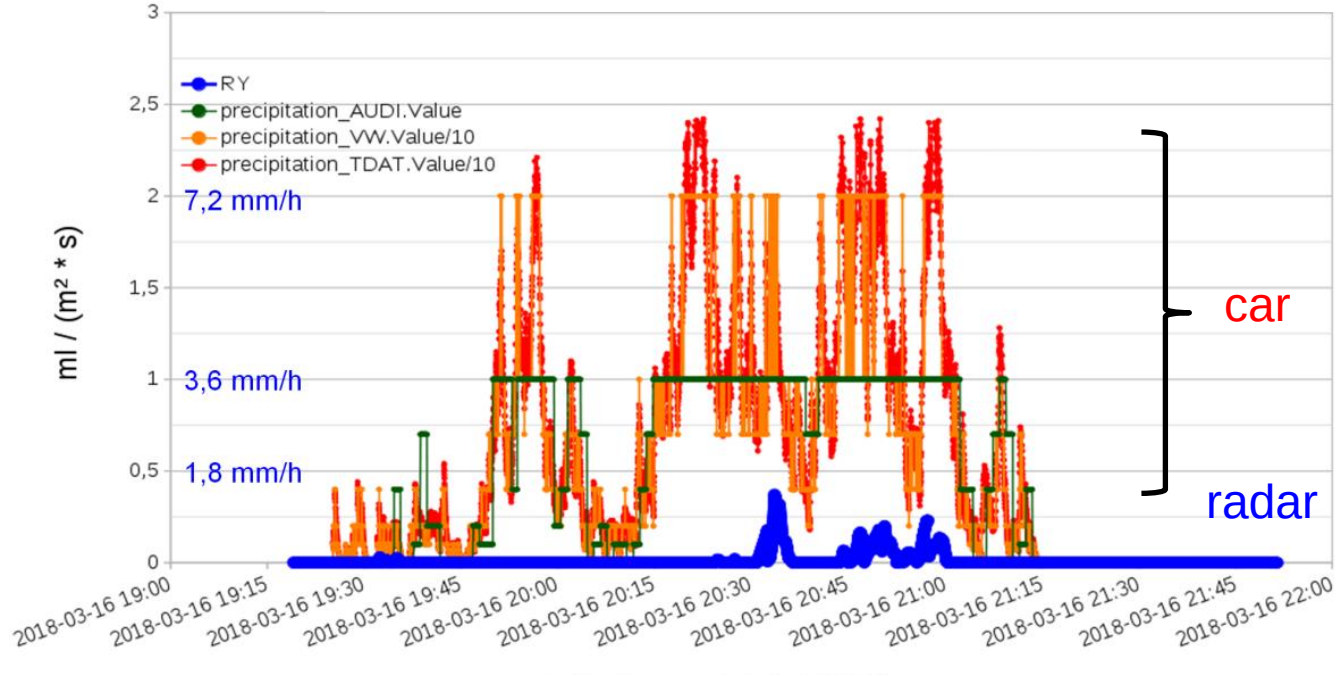
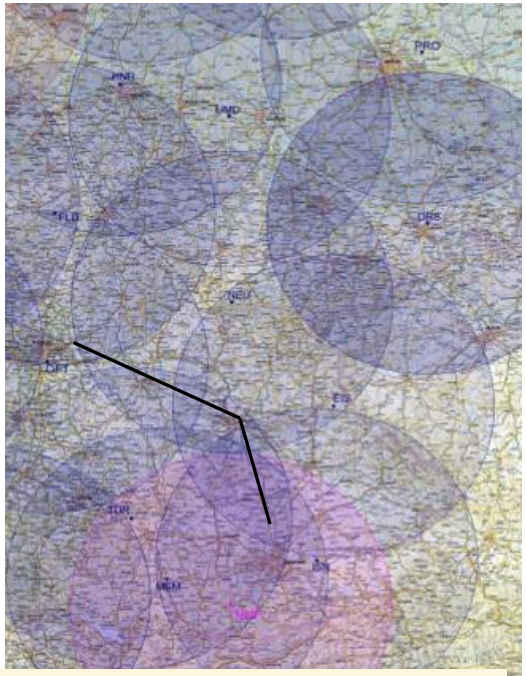
Wetter und Klima aus einer Hand

16 Mar 2018 Offenbach → Ingolstadt




radar sites



**Cause of difference?**

- **Radar** (wind drift? not: evaporation, radar would be above ground observations)
- **point** measurement vs. **grid** (precipitation is spatially inhomogeneous)
- **car sensors** overestimate amount of rain (e.g., spray) or correct vehicle speed wrongly

# Rainfall in ‘2D’ on radar and car time axis

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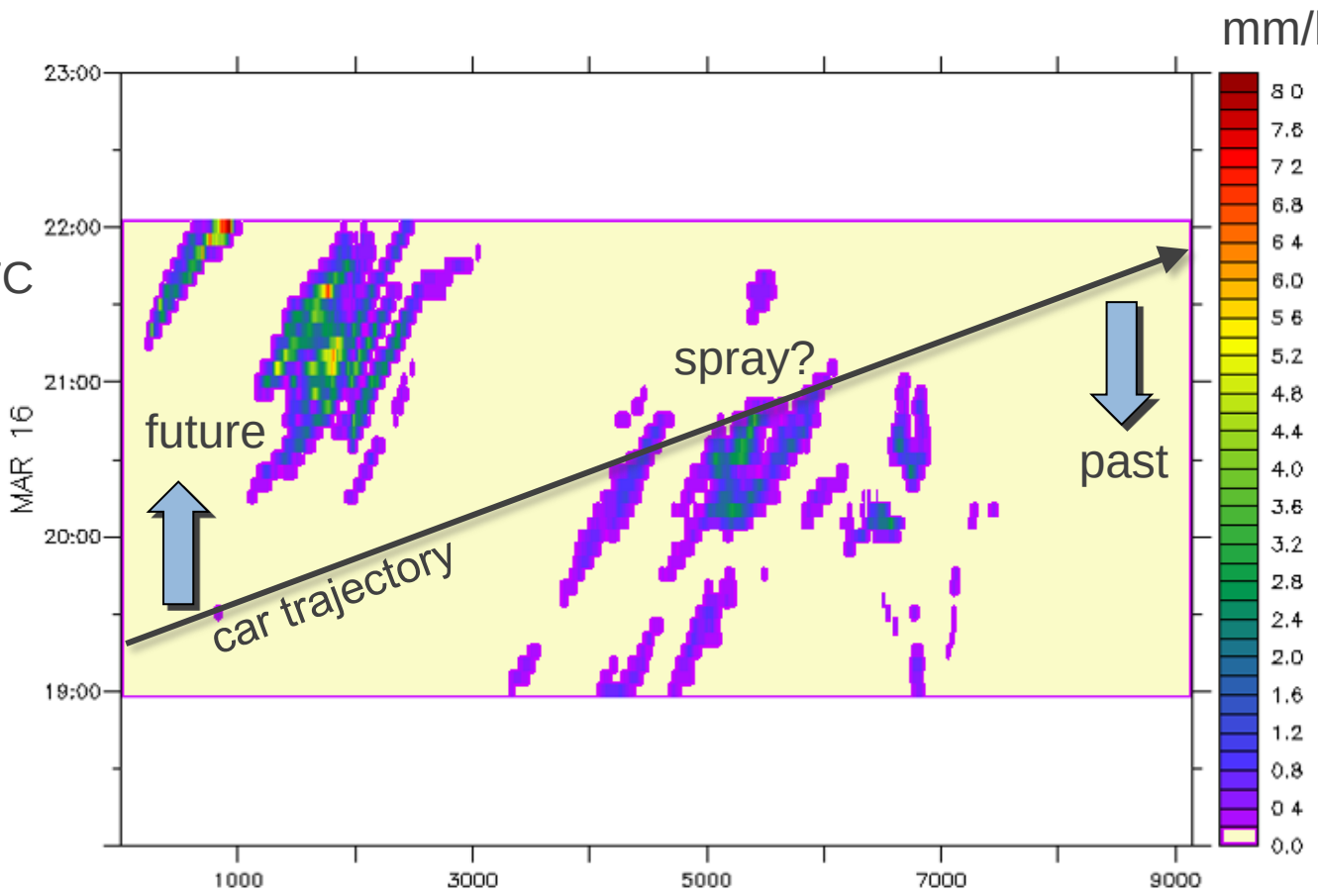
time axis
Radar UTC



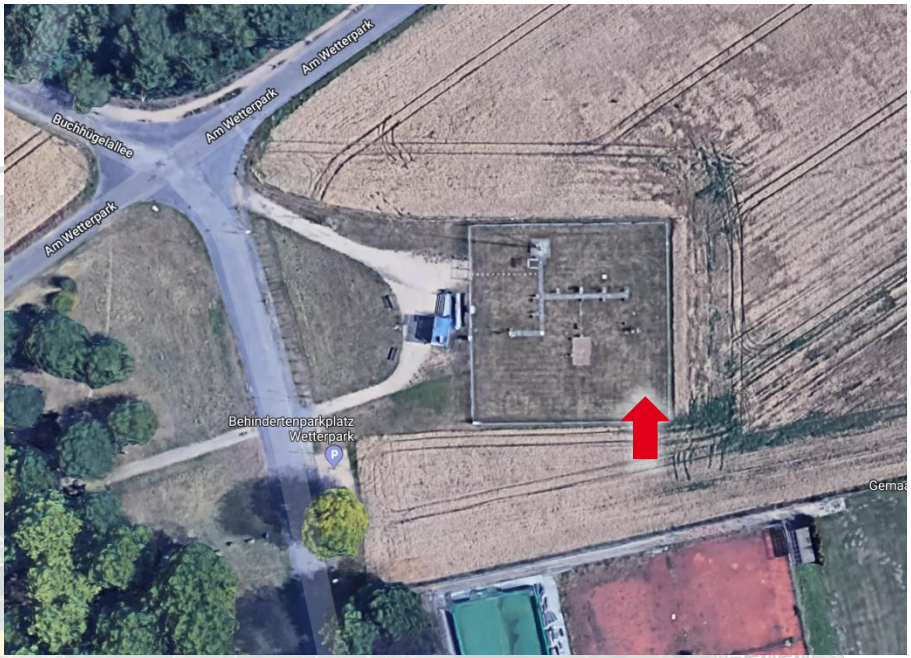

time axis car (seconds) DWD OF → Audi Ingolstadt

**amount of precipitation**

RY (mm/h) radar composite 1km x 1km

**→ We need controlled in-situ comparisons (with ground truth)**

# Audi “weather box“ near DWD



# Audi “weather box“ at synoptical station

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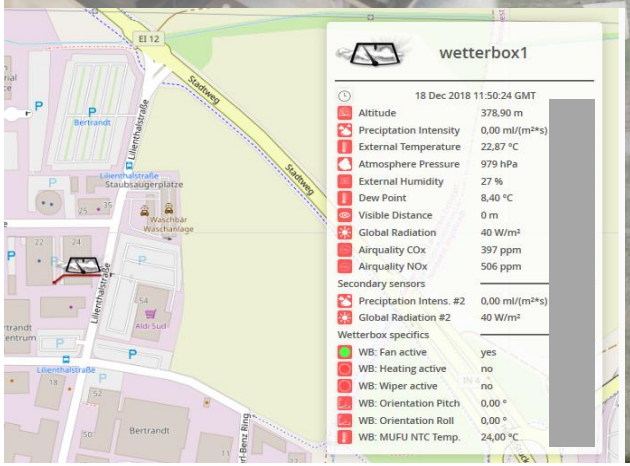




- Audi “weather box”: car sensors put together as weather station
- direct comparison to DWD synoptical station with established data quality

# Campaigns → controlled test drives



- **control stations**:
  - road weather stations (RWS), synoptical weather stations (Synop)
  - Meteorological Observatory Hohenpeißenberg

Synop

RWS

- **partners**:
  - measuring vehicles at DWD (MME)
  - measuring vehicles at regional road authority of northern Bavaria (ABDNB)
  - measurement field of ABDNB
  - measurement fields at German Federal Highway Research Institute (BASt)

ABDNB

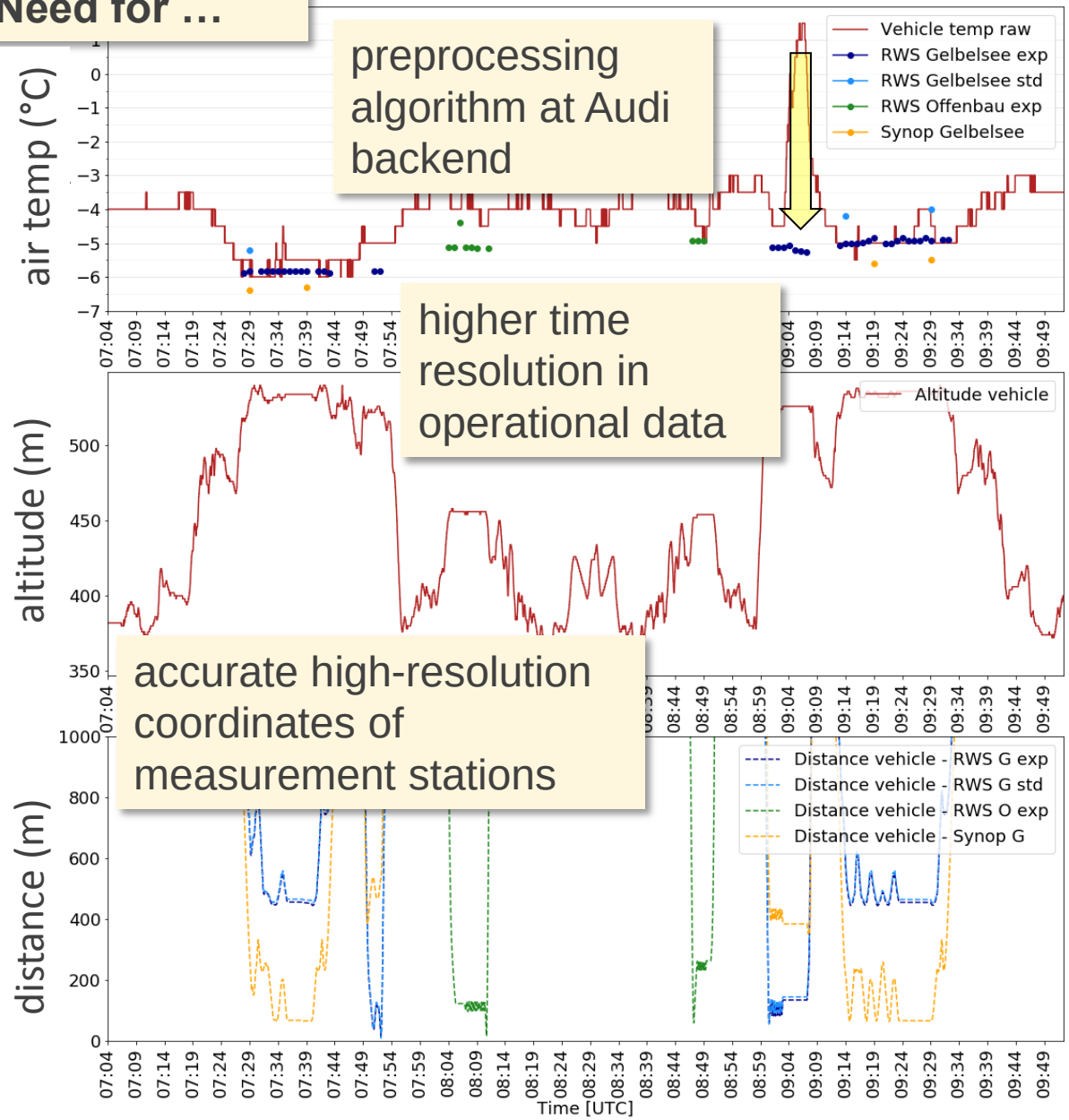
MME

## Need for …

preprocessing algorithm at Audi backend

higher time resolution in operational data

accurate high-resolution coordinates of measurement stations

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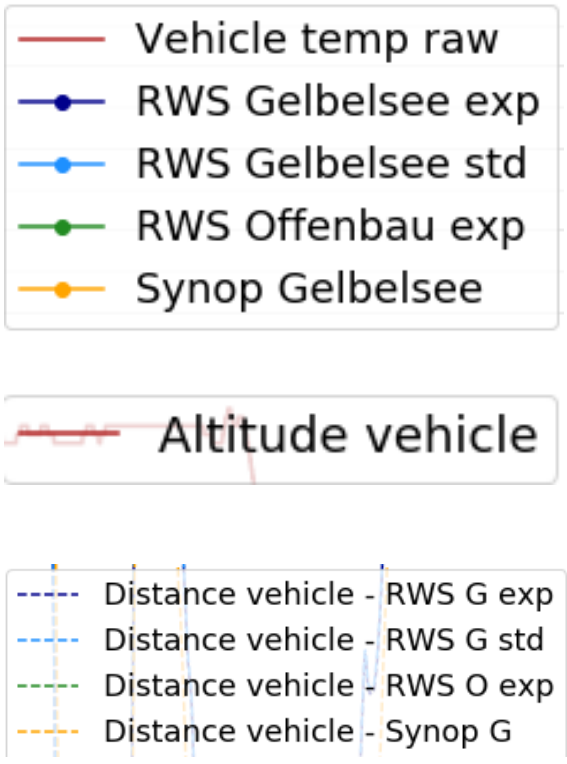
## at a synop station



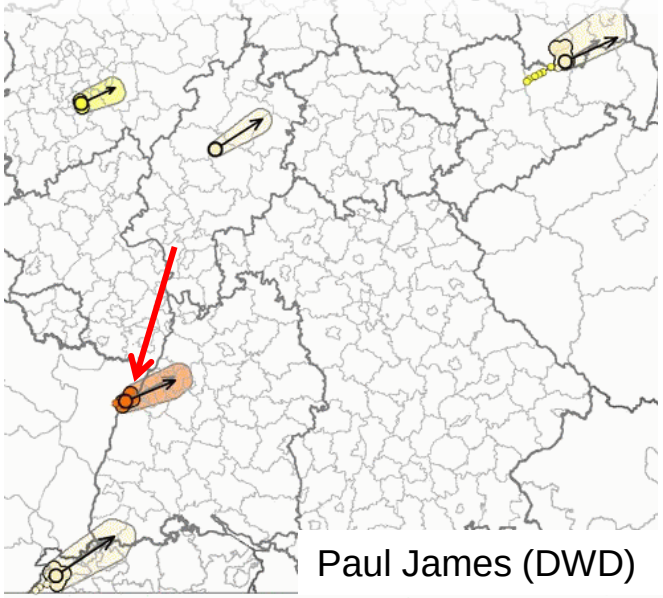
# Outlook



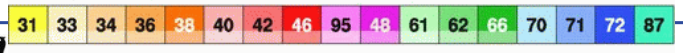

**NowCastMIX** 5-min updates

**precipitation, thunderstorms, snow, freezing rain**

Input data: radar, thunderstorm cell detection, lightning, satellite data, NWP

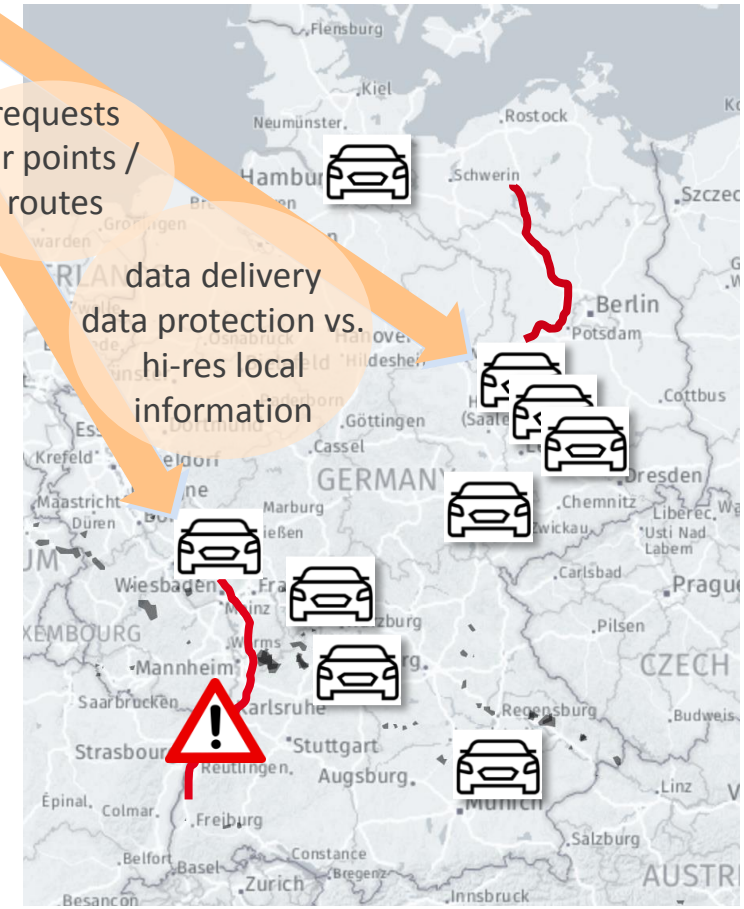


Paul James (DWD)




requests for points / routes

data delivery data protection vs. hi-res local information



# Thank you for your attention!

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Deutscher Wetterdienst

Remote sensing application development (FE23)

Project FloWKar – weather maps based on car sensor data